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RESEARCH ARTICLE

INVIVO PHARMACOLOGICAL SCREENING OF HYDROALCOHOLIC EXTRACT OF *SOLANUM MELONGENA* AND *SOLANUM LYCOPERSICUM LEAVES* FOR ANALGESIC AND ANTI-INFLAMMATORY ACTIVITY

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ABSTRACT

Solanum melongena (SM) or eggplant and *Solanum lycopersicum* belongs to the family *Solanaceae*. The present research work investigates the effects of combination of both extracts for analgesics and inflammatory activities. Fresh leaves were collected, weighed, grinded and mixed into fine powder followed for Soxhlet extraction using hydro-alcohol (50-50%) as solvent. The analgesic and anti-inflammatory activities were investigated using eddy's hot plate method and formalin induced paw oedema model using plethysmograph. Albino Wistar rats of either sex were divided into 4 groups each containing six animals where control group is treated with saline, standard group with (diclofenac sodium 10mg/kg-i.p.), test groups with hydro-alcoholic leaf extract of *Solanum melongena* and *Solanum lycopersicum* at doses 150mg/kg and 300 mg/kg (orally). The extracts showed significant analgesic and anti-inflammatory activity at the dose of 300mg/kg with respect to standard drug diclofenac sodium (10mg/kg). Analgesic activity using eddy's hot plate method screened based on time taken to show pricking and licking movements showed significant analgesic activity at 300 mg/kg (9.08±0.19sec) similar with standard drug (8.9±0.39sec). Anti-inflammatory activity screened using formalin 5% (0.01ml) induced paw edema model. Standard group showed 77.61% decline in inflammation whereas the group receiving 300mg/kg also showed 73.77% decrease in inflammatory response measured using rise in mercury levels. The results indicate the leaf extracts at doses of 300mg/kg showed good analgesic and inflammatory activity due to synergistic effect.

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INTRODUCTION

"Pain an unpleasant, sensory and emotional experience associated with actual or potential tissue damage or described in terms of damage".Any kind of pain is a part of a person's existence. An essential component of healthcare is theprevention and treatment of pain. Pain disorder development and progression are significantly influenced by the psychological variables. Different anatomical regions including the lower back, head area, abdomen and chest are the parts that are mostly affecting with pain (Kumar, 2016). An analgesic is a drug that selectively decreases pain by affecting the central nervous system or peripheral pain mechanisms without significantly altering awareness.Pain is a warning indication that is mainly protective in nature.Other side effects of excessive pain include nausea, palpitations, sweating, anxiety, an increase or fall in blood pressure, and tachypnea (Deshmukh, 2014). Pain, a warning sign of tissue damage sent by specialized receptors and fiber systems reach from the periphery to the brain. When typical pathways are disrupted, the immediate result is loss or impairment of function, including discomfort (Gautam, 2013).

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The class of medications known as analgesics or painkillersare used to treat analgesia or pain reduction. Analgesic neutralizes the central and peripheral nerve pain in a variety of ways. Other analgesics, such as narcotics usually don't help with pain from nerve degeneration including stabbing and dysaesthetic symptoms. The type of analgesic referred for person depends on the type of pain, its location and degree of severity (Twycross, 1984)

Introduction to inflammation: "Inflammation is a part of the complex biological response of vascular tissues to harmful stimuli, such as pathogens, damaged cells or irritants". Inflammation is a normal, protective response to tissue injury caused by physical trauma, noxious chemicals or microbiological agents. There are mainly two types of inflammation as follows:

1. **Acute inflammation:** It is associated with increased vascular permeability, capillary infiltration and emigration of leukocytes.
2. **Chronic inflammation:** It is associated with infiltration of mononuclear immune cells, macrophages, monocytes, neutrophils, fibroblast activation, proliferation (angiogenesis) and fibrosis (Kumar, 2013).

Inflammation is indicated by redness, heat, swelling and influx of plasma proteins and phagocytic cells into the tissue spaces resulting pain due to hyperalgesia, release of local enzymes or increased tissue pressure with consequent loss of function (Fokunang, 2018). Non-steroidal anti-inflammatory drugs (NSAIDs) are a class of medications that include analgesics (drugs that reduce pain), antipyretics (drugs that lower fever) and at higher dosages to treat inflammation. The analgesic and anti-inflammatory properties act by nonselectively inhibiting isoenzymes of prostaglandin synthase, cyclooxygenase (COX). Non-steroidal anti-inflammatory drugs (NSAIDs) are the most widely prescribed over the count drugs for the treatment of pain and inflammation in many conditions, including osteoarthritis and rheumatoid arthritis (Tracy et al., 2006).

Introduction to plants

***Solanum melongena and Solanum lycopersicum*:** Medicinal plants are in use as dietary supplements since decades with therapeutic activity. The plants have their role in diet aswell as in therapy. The Indian medical system has made use of *S. melongena* (Brinjal), a culinary vegetable, regarded as a medicinal herb (Gul, 2011). The vegetable crop species eggplant (*Solanum melongena L.*) is a member of the Solanaceae family, the largest plant in use from the family. Eggplant (also known as brinjal, aubergine, melanzane or berenjena), is an economically important vegetable crop of tropical and subtropical zones and their cultivars produce wide fruit diversity with different shapes, sizes and colors. Originated in India but migrated gradually to Mediterranean, Africa, Europe, and America before being grown all over the world today. China and Japan are its secondary places of origin (Niño-Medina, 2017). One of the most widely grown and consumed vegetable worldwide, eggplant (*Solanum melongena L.*) is a significant source of minerals like magnesium, phosphorus, potassium, manganese, and copper; dietary fiber; folic acid; and vitamins B6, C, K, thiamin, niacin, and pantothenic acid (Slomy, 2019). The reported activities on the plant are listed below in Table 1.

***Solanum lycopersicum*:** The *S.lycopersicum* herb, tomato that is cultivated in houses or in fields as vegetable, that is usually found as weed in field crops. To overcome unfavourable field conditions, they demonstrate rapid growth and development of asexual reproductive organs (Dhima, 2016). The plant has unique characteristics including fleshy fruit and compound leaf. Nearly 13 varieties of tomatoes are cultivated. They are used as both food as well as research material. These wild tomatoes are useful for breeding, obtaining desirable features and conducting evolutionary studies (Kimura, 2008). *Solanum lycopersicum*, also known as tomato plant, contains high quantities of chlorogenic acid. Tomato varietals include high levels of polyphenols, including caffein, P-coumaric acid, ferulic acid and chlorogenic acid (Kumar, 2021 and Singh, 2023). The reported activities on tomato plants are listed in the Table 2 below.

MATERIALS AND METHODS

Method of Extraction: The leaves of *Solanum melongena*and *Solanum lycopersicum*were collected from fields of Yellamanda near by our college. The plants are authentified from Acharya Nagarjuna University, Guntur by Dr. P. Satyanarayana Raju Taxonomist as HN-21 (Department of botany and Microbiology). The leaves are washed to remove the dust particles and are cleaned toremove the moisture. The leaves are shade dried. After drying the leaves are grinded into fine powder. The powders were weighed separately and equal quantities are mixed and subjected for Soxhlet extraction using hydro-alcohol (50-50%) as solvent. The extract is filtered and concentrated using condenser. The concentrated extract is evaporated to remove traces of solvent molecules and the extract is packed in air tight container for further use. The extract is subjected for phytochemical investigation.

Animal Procurement: Albino Wistar rats of either sex weighing between 150-300 grams were selected for screening of analgesic and anti-inflammatory activities. The animals are survived in controlled environment with a 12-hour light dark cycle with relative humidity of 50±5%RH and temperature of 21±2°C. They were fed with a standard pallet diet ad libitum. All experiments adhered to the National institutes of health guidelines (guide for the care and use of laboratory animals) and the standards set by the International Association for the Study of pain to minimize the animals used and reduce discomfort (Zimmerman al…, 1983, National institutes of health 1985).

Table 1. Table indicating reported activities in*Solanum melongena*.

S.no.	Name of the activity	Author	Published year
1.	Analgesic activity	*Maniyar. YA. et al..,*[12]	2015
2.	Anti-inflammatory activity	*Umamageswari. MS. et al..,*[13]	2015
3.	Antioxidant activity	*Sudheesh. S. et al..,*[14]	1999
4.	Immunomodulatory activity	*Pandey. N. et al..,*[15]	2022
5.	Anticancer activity	*Winkiel. MJ. et al..,*[16]	2022
6.	Anti-bacterial activity	*Kamatchi. T et al..,*[17]	2023
7.	Anti-ulcer activity	*Srinivas [1]. RL. et al..*[18],	2013
8.	Anti-microbial activity	*Maniyar. YA. et al..,*[19]	2015

Table 2. Table indicating reported uses *of Solanum lycopersicum*

S.No.	Name of the activity	Author	Published Year
1	Anti-inflammatory activity	*Amid. A. et al.. ,*[24]	2011
2	Antioxidant activity	*Riahi. A. et al..,*[25]	2013
3	Immunomodulatory Activity	*Choudhary. I. et al.,.* [26]	2021
4	Anticancer activity	*Sathelly. K. et al..,*[27]	2022
5	Anti-bacterial activity	*sajet AL-Oqaili. RM. et al..,*[28]	2014
6	Hepatoprotective activity	*Weremfo.A. et al..,* [95]	2011
7	Anti-ulcer activity	*Wibowo. DP. et al..,* [30]	2023
8	Anti-microbial activity	*Hraishawi. RM. et al..,*[31]	2020
9	Anti-proliferative activity	*Mutalib. MA. et al.. , ,* [32]	2023
10	Anti-diarrheal activity	*Andleeb.R. et al..,*[33]	2023
11	Anti-urolithiasis activity	*Waghmare.S. et al..,*[34]	2020

Animals were ascribed randomly to different groups to eliminate bias and the researcher conducting the behavioural observations is blinded to the treatment groups to ensure objectives assessment of the results. The study received approval from the animal ethics committee, Narasaraopeta Institute of pharmaceutical sciences, Narasaraopeta, Andhra Pradesh, India with code 1414/A/11/CCSEA/NIPS/ IAEC/2025/003.

Analgesic activity using Eddy's Hot plate method: Albino wistar rats (weighing 150-300 grams) are divided into groups each consisting of

six animals. The animals are placed individually on preheated pan on eddy's hot plate maintained at temperature 55-60°C, noting the time taken for the animals to show pricking and licking responses. A cut off time of 15sec is set in order to prevent unnecessary pain or injury to the animals. The overnight fasting animals are divided into groups. All the animals in the group are screened for analgesic activity and the time taken for animals to show responses are noted. Control group is treated with saline, standard group is treated with diclofenac sodium (10mg/kg i.p.) and test groups with extract 150mg/kg and 300 mg/kg orally. After respective time lapse for a duration of 15min for standard group and 30 min for test groups the animals are again subjected for screening using eddy's hot plate. Compare the time taken for the animals to show pricking and licking movements before and after drug treatment.The means of all the values are determined and the significance value is calculated using GRAPH PAD PRISM 5.0 (Jahanabadi, 2022).

Anti-inflammatory activity measuring Paw oedema using plethysmograph: Albino Wistar rats (weighing 150-300 grams) are divided into four groups of six animals each: a control group is treated with solvent, standard group treated with diclofenac sodium (10 mg/kg i.p.), and a test group treated with hydro-alcoholic leaf extract of 150mg/kg and 300 mg/kg oral. The initial paw volume of each rat was measured using a plethysmograph by noting the mercury rise in the column when the hind paw is dipped. The standard group is treated diclofenac and test groups are treated with plant extracts. After 15 minutes time lapse for standard group and 30 minutes time lapse for test group, 0.01 ml of formalin (5%) is injected into the left paw of each animal as inducer of inflammation. The volume of both the right and left paws is measured again to assess the effect of the drug and extract on the paw inflammation.The percentyl decline in inflammation was calculated by determining the difference in the paw volume before and after inducing inflammation. The means of all the values are determined and the significance value is calculated using GRAPH PAD PRISM 5.0 (Jahanabadi, 2022).

RESULTS

Phytochemical screening results: A small quantity of drug is dissolved in 10% DMSO and is subjected for phytochemical screening inorder to identify the Phyto-constituents present in the extract. The results are tabulated in the Table 3 below.

Analgesic activity using Eddy's Hot plate method: The results for *invivo* screening of analgesic activity using eddy's hot plate are organised in the table 4 below and the graphical presentation is represented in the Figure 1.

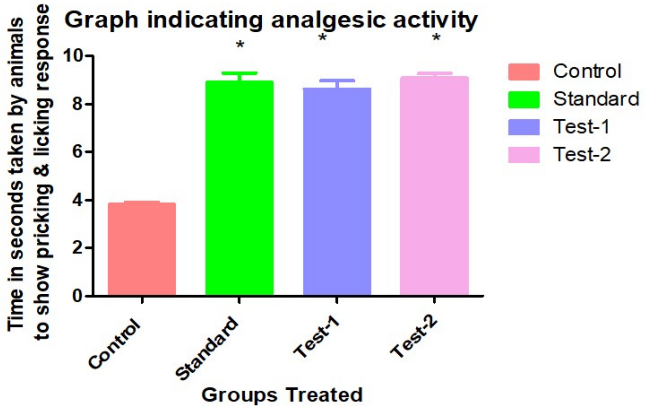

Figure 1: Figure showing results of analgesic activity using Eddy's hot plate

Anti-inflammatory activity measuring Paw oedema using plethysmograph: The results for *invivo* screening of anti-inflammatory activity using plethysmograph measuring the paw oedema using mercury volume rise are organised in the Table 5 below and the graphical representation is viewed in Figure 2.

Table 3. Table indicating results of phytochemical screening of hydro-alcoholic leaf extract of *Solanum melongena* and *Solanum lycopersicum*

S. No.	Test	Result	Observation
1	Mayers test	+	Presence of alkaloids
2	Hager's test	+	Presence of alkaloids
3	Millon's test	++	Presence of proteins
4	Ninhydrin test	++	Presence of proteins
5	Molisch test	+	Presence of carbohydrates
6	Fehling's test	+	Presence of carbohydrates
7	Ammonium test	+++	Presence of flavonoids
8	Ferric chloride test	+++	Presence of phenolic compounds
9	Bontrager's test	_	Absence of glycosides
10	Keller Killian test	_	Absence of glycosides
11	Gelatin test	_	Absence of tannins

(+) Presence of compound (-) Absence of compound

Table 4. Table indicating results of analgesicactivity using Eddy's hot plate

S.No.	Group	Drug treated	Dose	Time taken to show pricking& licking movements
1.	Control	Vehicle	1ml	3.82±0.09
2.	Standard	Diclofenac sodium	10mg/kg-i.p.	8.9±0.39*
3.	Test-1	Leaf extract of *S.melongena* & *S.lycopersicum*	150mg/kg-o-1ml of 10% DMSO	8.62±0.35*
4.	Test-2	Leaf extract of *S.melongena* & *S.lycopersicum*	300mg/kg-o-1ml of 10% DMSO	9.08±0.19*

P values, ***P<0.001- highly significant, **P<0.01- Significant P values, *P<0.05 indicating the values are significant.

Table 5. Table indicating results of anti-inflammatory activity measuring Paw oedema using plethysmograph

S.No.	Group	Drug treated	Dose	Initial paw volume	Final paw volume after inducing inflammation	Difference in volume	Percentyl inhibition
1.	Control	Vehicle	1ml	1.02±0.07	1.63±0.02	0.61±0.05	100%
2.	Standard	Diclofenac sodium	10mg/kg-i.p.	1.07±0.06	1.09±0.01	0.15±0.02*	77.61%
3.	Test-1	Leaf extract of *S.melongena* & *S.lycopersicum*	150mg/kg-o-1ml of 10% DMSO	1.02±0.06	1.20±0.06	0.18±0.01*	70.49%
4.	Test-2	Leaf extract of *S.melongena* & *S.lycopersicum*	300mg/kg-o-1ml of 10% DMSO	1.02±0.07	1.18±0.00	0.16±0.01*	73.77%

P values, ***P<0.001- highly significant, **P<0.01- Significant P values, *P<0.05 indicating the values are significant.

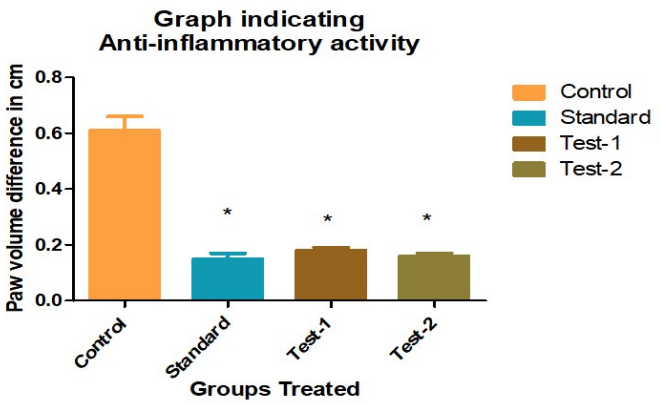

Figure 2. Figure showing results of anti-inflammatory activity measuring Paw oedema using plethysmograph

SUMMARY & DISCUSSION

Solanum melongena and *Solanum lycopersicum* are popular medicinal herbs employed for treating various diseases. The present research focuses on screening of leaves of *Solanum melongena* and *Solanum lycopersicum* for analgesics and anti-inflammatory activity. Fresh leaves are collected from fields near by yellamanda and shade dried. After drying the leaves are grinded into fine powder and subjected for extraction. Extraction is done with hydro-alcohol (50-50%) for 3 constitutive days using Soxhlet apparatus, followed by vacuum filtration. The extract was concentrated using reflux condenser and the concentrated extract was made solvent free by evaporation to separate extract. Hydroalcoholic leaf extract of *Solanum melongena* and *Solanum lycopersicum* was about 7.49 g. A small quantity of extract is dissolved in 10% DMSO and is subjected for phytochemical screening to evaluate the presence of Phyto-constituents. The phytochemical results indicates that the hydro-alcoholic leaf extract (50-50%) contains major amounts of flavonoids and phenolic compounds with moderate amounts of proteins and minor amounts of carbohydrates and alkaloids with absence of glycosides and tannins.

Screening for analgesic and anti-inflammatory activity is performed by using eddy's hot plate method and Formalin induced paw oedema models. The time taken by animals to show paw flinching behaviour for analgesic activity and volume of mercury rise in plethysmograph for anti-inflammatory activity was observed. For analgesic activity animals are divided into 4 groups eachgroup containing 6 animals. Control group is treated with saline and standard group is treated with Diclofenac sodium (10mg/kg-i.p.). Test groups are treated with 150 and 300mg/kg-(o) of hydroalcoholic leaf extract of *Solanum melongena* and *Solanum lycopersicum*. The animals are treated with drugs and after time duration i.e. 15 min for standard group and 30 min for test groups, the animals are subjected for screening of analgesic activity. The time taken for the animals to show paw licking and pricking behaviour was noted. The time taken for animals to show pricking and licking behaviour for control group is 3.82±0.09 sec, for standard group is 8.9±0.39 sec, for test groups with 150mg/kg-(o) is 8.62±0.35sec and for test group with 300mg/kg-i.p. Is 9.08±0.19sec. It was clear the test group receiving 300mg/kg showed maximum response with standard group indicating the extracts are showing good analgesic activity. The synergistic effect is responsible for showing good pharmacological activity compared with standard. For anti-inflammatory activity animals are divided into 4 groups each containing 6 animals. Control group treated with saline and standard group is treated with Diclofenac sodium (10mg/kg-i.p.). Test groups are treated with 150 and 300mg/kg-(o) of hydroalcoholic leaf extract (50-50%) of *Solanum melongena* and *Solanum lycopersicum*. The animals are treated with drugs and after time duration i.e. 15 mins for standard group and 30min for test groups, the animals are subjected for screening of anti-inflammatory activity using plethysmograph where the inflammation is induced with formalin 5% (0.01ml).

The paws of the animals are dipped in mercury using plethysmograph and the level of rise in mercury level is monitored. Initial paw volume without giving drug and inducer is noted and final paw volume after treating with drug and inducer is noted. The difference in paw volumes is noted. The volume of mercury level rise for control group is 0.61±0.05, for standard group is 0.15±0.02, for test groups with 150mg/kg-(o) is 0.18±0.01 and for test group with 300mg/kg-i.p. Is 0.16±0.01. It was clear that the test group receiving 300mg/kg showed maximum response with standard group indicating that extract is showing good anti-inflammatory activity. For anti-inflammatory activity the standard drug diclofenac sodium 10mg/kg-i.p. Showed 77.61% decrease in inflammation whereas test drug at dose of 300mg/kg showed 73.77% decrease in inflammation nearer to standard drug.The minor deflection compared with standard drugs may be rectified by taking pure isolated drugs.

CONCLUSION

Solanum melongena and *Solanum lycopersicum* are medicinal herbs used in treating various diseases. The present research focuses on treating analgesic and anti-inflammatory activity. Leaves are selected for screening of analgesic and anti-inflammatory activity. Fresh leaves are collected from fields, dried, grinded and extracted with hydro-alcoholusing continuous hot percolation. The phytochemical results indicates that the hydro-alcoholic leaf extract (50-50%) contains major amounts of flavonoids and phenolic compounds with moderate amounts of proteins and minor amounts of carbohydrates and alkaloids with absence of glycosides and tannins. Hot plate method and formalin induced paw oedema models were performed to find out the analgesic and anti-inflammatory property. Animals are divided into four groups each containing six animals treated with saline, standard drug (diclofenac 10mg/kg), Hydro-alcoholic leaf extract of *Solanum melongena* and *Solanum lycopersicum* at doses 150mg/kg and 300mg/kg respectively.

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